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Department of Plant Pathology

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THE FIRE BLIGHT DISEASE AND ITS CONTROL IN NURSERY STOCK

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Fire blight is undoubtedly a native disease of the American indigenous species of Pomeae. It is known to affect the pear, quince, apple, apricot, plum, species of *Crataegus*, mountain ash, service berry, and a few of the native species of the apple family. Its occurrence has been reported on the evergreen *Eriobotrya japonica* and the red-berried California holly (*Heteromeles arbutifolia*).

The disease is most destructive on the cultivated varieties of pear, apple, and quince. Intensive cultivation and artificial propagation have evidently tended to reduce resistance to the blight in these plants. Plums and apricots are seldom affected, while cherries and peaches are not known to be attacked.

SUSCEPTIBILITY OF VARIETIES

Opinions disagree markedly concerning the susceptibility of different varieties to this malady. So far as is known, however, all varieties of pears, apples, and quinces may be attacked under conditions favorable for the disease.

Apparently the most important factor that influences the spread of the blight is the period of growth-activity of the tree. The more succulent the tree, the more severely it is attacked. When the trees begin to mature and the twigs become hard and woody, the blight is not so destructive. Trees under cultivation make a longer and more succulent growth throughout the growing season and are naturally more susceptible to the disease for a greater period of time than the slow-growing, hard, and woody twigs on trees that have received less cultivation and care.

The fact that some varieties blight more readily than others may be due to the difference in the period of growth. Certain varieties of pears, especially, harden up sooner than other varieties; consequently the twigs are susceptible to the blight for a shorter period during the growing season.

WEATHER CONDITIONS AFFECT SUSCEPTIBILITY

The weather conditions at certain times during the growing season are an important consideration in the dissemination of blight in the nursery.

Prolonged hot and dry weather, in the early part of the season, tends to check the rapid development of the young shoots, causing them to make a hard, woody growth. The terminal buds close up and cease growing. Such shoots are not so liable to infection, and usually epidemics of the disease subside somewhat during a hot, dry period. Later, with an increased precipitation the growth of the trees is accelerated, and their tissues become tender and succulent and are naturally in a condition to be more susceptible to the blight.

The prevalence of the disease is also more noticeable in the infected trees after abundant rainfall followed by periods of hot, cloudy weather. The tissues are gorged with sap and thus favor the increased spread of the malady.

THE DISEASE

History

Fire blight has been a theme for incessant discussion by horticulturists since the earliest days of fruit culture in this country. Various common names have been applied to the disease, depending to some extent on the host that is attacked and on the effect produced. Among the names most frequently used are fire blight, pear blight, blight, blossom blight, twig blight, fruit blight, sun scald, canker, and blight canker. The term "fire blight" is preferable, since it applies equally well to the characteristic symptoms of the malady on any of the different hosts.

Occurring as a disease of the indigenous wild crab-apple and hawthorn of eastern North America, the blight spread readily to orchards of pome fruits when the cultivated varieties were introduced into this country. It was first observed about 1780 in the Hudson River Highlands of New York State. The disease is now found throughout the United States and Canada in practically every section where pomaceous fruits are grown. No authentic records have been made of its occurrence in Europe or in any of the other continents.

Without question it is the most important disease affecting the pomaceous fruits. Being epidemic in its nature, it may suddenly appear in a locality with increased prevalence and cause complete destruction or severe injury to the fruit trees of that section. Although it may subside as an epidemic, it is usually found to a limited extent in any locality and under favorable conditions it again becomes a destructive malady. Usually in the nursery it means total loss to the trees affected, and often within a comparatively short time thousands of young trees are ruined by its rapid spread through the blocks.

Symptoms

The limbs, blossoms, twigs, and fruit may be attacked. In the nursery the disease is most commonly found affecting the twigs. In the case of two- and three-years-old quince stock, however, the trees often blossom profusely in the spring, and when this happens blossom blight frequently occurs.

Blossom blight.—The blight first attracts special attention sometime in the early part of the season, usually two or three weeks after the blossoming period. The first evidence of the trouble is the brown, and subse-

quent blackened, appearance of the young leaf tufts and the blossoms, from which the disease extends rapidly into the fruit spurs. It prevents the development of the fruit and may even involve the larger twigs and branches.

Twig blight.— The wilted and brown or dead appearance of the stem and foliage is the characteristic symptom of twig blight. The progress of the disease down the stem, in the early stages, may be in advance of any



FIG. 68.—*Blossom blight of quinces. (One spur broken over in order to bring in focus)*

marked discoloration of the foliage, and to a considerable degree the blighted twigs resemble green brush that has been only partially burned. There is generally a viscid, milk-white substance exuding in small drops on the surface of the twig or the petioles, which later becomes oxidized into an amber-yellow, and finally into a dark brown or almost black gum. The extent of the disease in advance of any discoloration of the foliage may be determined by the sappy and juicy appearance of the stem tissue. A faint amber-yellow or reddish discoloration is often a means of detecting

affected apple shoots, while blighted pear twigs show an intensive blackening of the tissue even in the early stages of infection. In all host plants, however, the blight ultimately produces the same effect—the leaves shrivel, turn brown or black, and resemble foliage that has been killed by frost.



FIG. 69.—Blighted and healthy quince shoots. The characteristic brown color of the leaves on the blighted shoot does not show in the photograph

One of the most striking symptoms of fire blight may be recognized in the twig or limb with the dead, brown or black leaves clinging to it, contrasting sharply with the dark green foliage in summer and the naked branches of the trees in winter. In no other disease of the pome fruits do the leaves cling so tenaciously to the dead twigs.

Body blight.

The blight often works down the twigs and branches into the trunk of the tree and, within a short time, may extend into the roots. At the termination of the growing season the active progress of the malady becomes checked, and dark, discolored areas, with a sharp line of demarcation, indicate the limits of the disease. These diseased areas surrounded by healthy bark are known as cankers.

Winter injury versus fire blight

Changeable weather conditions during the dormant season may cause severe injury to the fruit stock in the nursery, and frequently such injury is confused with fire blight. The results of winterkilling are usually manifest early in the spring by the injury to the trunks of the trees. There occur large cankered areas, which may completely girdle the tree and partially interfere with, or totally inhibit, the development of the new growth. If the injury has not been too severe some new growth may be made, but from lack of nourishment the young shoots soon wilt, turn brown, and die within a short time, their condition thus resembling closely that brought about by fire blight. On the other hand, winterkilled trees show a uniform browning, or dying, of all the foliage; whereas with fire blight, in the early stages the dead discoloration is from the tip downward as the disease progresses toward the main part of the tree. The shoots of winterkilled trees appear wilted and dried, due to inadequate food supply, and there is no gummy exudation nor water-soaked appearance so common with blighted twigs.*

*It has been the experience of the writer that in blocks of two- and three-years-old apple and quince trees, when an abundance of both fire blight and winter injury is apparent winter-injured trees seldom, if ever, blight.

Cause of the disease

The disease is caused by a species of bacteria (*Bacillus amyliovor*us). Individuals of this species are very minute, rod-shaped plants, so small that it would require 25,000 of them placed end to end to make an inch. They can be seen only when magnified several hundred times under the microscope. They are covered with fine, hair-like flagella, which enable them to swim about in the juices of infected tissues of the host plant. They multiply by lengthening slightly and dividing into two at the middle, then growing to normal size and dividing again. The process is repeated about every half hour so long as conditions are favorable for their development (Fig. 69).

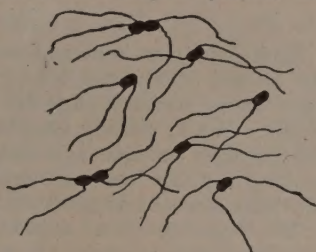


FIG. 70.—*Bacillus amyliovor*us, the species that causes the blight. Note that the bacteria multiply by dividing into two

Life cycle of the germ

The bacteria remain alive throughout the winter in some of the cankers in the body, the limbs, or even the twigs of the tree. With the ascent of the sap and the increased temperature of spring, the organisms in the so-called "hold-over" cankers become active again, multiply, and spread into the adjoining healthy bark. Often, when their increase is augmented by warm, rainy weather the gummy exudation, laden with bacteria, oozes out of the lenticels and cracks of the infected bark. This exudation, containing millions of the minute bacteria, usually occurs first about the time when the blossoms are opening. Various insects, such as wasps, honeybees, and flies, are attracted to the hold-over cankers by the sweet, gummy exudate, become smeared with it, and carry the infection material to the blossoms. Some of the bacteria brought by the infected insect are left in the nectar of the flower. The sweet solution greatly favors the multiplication of bacteria, and the next bee or other insect carries the organism to all succeeding blossoms that are visited. The bacilli penetrate the tender tissues of the flower, and within nine or ten days the characteristic symptoms of blossom blight are apparent.

After the blossoming period, or sometimes even before it is entirely over, the blight may appear in the young, succulent shoots or twigs. Ordinarily in the nursery, where blossoms are not common except in the two- and three-years-old quince stock, the first occurrence of the blight in the spring is in the twigs. Instances have been observed, however, when the disease appeared first in the quince blossoms and spread later to the tender shoots. Not only do the new twig infections continue to occur throughout the summer, but the disease continues to spread in an affected tree and, unless checked, may involve the entire tree.

As a general rule the blight is first found in the two- and three-years-old trees; later, these trees are the source of infection for the spread of the disease to the first-year buds. The insects that disseminate the blight bacteria, such as the tarnished plant bugs, are most abundant on the

apple stock throughout the months of July and August, and usually the blight in the first-year buds is most severe at this time.

Disseminating agents

Such agents as bees and wasps have long been conceded important in the spread of blossom blight, but in recent years certain other insects have been associated with the spread of the disease, particularly with twig blight. While visiting blighted tissues the insect becomes smeared with the gummy exudate and carries the bacteria to the tender twigs. In sucking the sap from the twigs the insect punctures the tissue and thus furnishes a means of entrance for blight germs.

The common green aphids (plant lice) frequently spread the disease in apples and quinces. However, of all the sucking insects that may disseminate the blight bacteria in the nursery, perhaps the most important is the tarnished plant bug (*Lygus pratensis*). This insect has been recognized for many years as the cause of the severe injury to peach stock known as peach sting. The injury resulting from the insect's "stinging" the terminal shoot of the first-year peach buds causes the tree to make a stunted, bushy growth and to fall short of the proper height. During the past two seasons, not only has the peach stock been injured in this way, but considerable damage has been apparent in several blocks of first-year apple buds. A large number of apple shoots that had been stung by insects a few days previously developed infections of fire blight. When abundant in blocks of two-years-old stock (especially in apples where there may be considerable blight) the insects visit the sweet, gummy exudation on infected trees, and thus not only spread the disease to the large trees but carry the bacteria to adjoining blocks of one-year-old apple stock where infections occur through the punctures made by the insects.

Dissemination by pruning tools

Besides the general distribution of the blight germ by insects, man himself is often an active agent in spreading the parasite. His pruning tools are certainly a frequent means of transmitting the organisms. M. B. Waite, of the United States Department of Agriculture, writes: "In Maryland the writer once saw a nursery block of 10,000 trees of Bartlett and other pears completely destroyed by blight. This block, as determined by the specimen, carried actual samples of hold-over blight in the stocks. When the stocks were cut off above the dormant buds in the spring, the pruning tools became infected and the disease was transmitted to nearly every tree reached by the pruners. Instead of the buds pushing up, the cut surface began to gum and blight."

Blight is frequently introduced into seedling blocks by the use of diseased scions that have been cut from two- and three-years-old stock in which considerable blight has been present. The seedlings, which are budded with diseased buds, not only blight, but bacteria are carried on the budder's knives to other seedlings. Later, at rebudding time, the budders, being unfamiliar with the disease, frequently attempt to rebud the blighted stocks; their knives become infected and the bacteria are transmitted to other seedlings. The number of diseased seedlings is

also frequently increased when the strings used for tying the buds are cut. Often in cutting the string a slight incision is made in the bark and the trees are inoculated in this manner, blight germs having been carried on the knives from diseased stocks.

Blight may also be introduced into the seedling block by means of insects, which carry the bacteria to the tender shoots. Occasionally, entire trees become diseased in this manner. However, twig infections are seldom if ever so abundant in the seedlings as to be the source of a serious outbreak of the disease. On the other hand, an attempt to bud such infected seedlings would tend to favor the more rapid spread of the disease, the blight bacteria being carried to healthy trees on the budding knives.

The shipment of scions from one nursery to another may also be a means of transmitting the blight for long distances, and bacteria have even been known to live over in scions used for grafting purposes. In the winter, when the grafts were made, the grafting knives became infected and transmitted the blight bacilli to grafts made from healthy scions.

CONTROL

Spraying and blight remedies ineffective

Spraying the trees with a fungicide is not effective. The very nature of the method of introduction of the causal organism into the tree in most cases precludes this as an effective means of prevention. The bacteria are unable to penetrate the cuticle of the host tissue and can produce infection only when a means is afforded for their entrance into the bark tissue through a wound or puncture.

Making the trees immune by the introduction of different substances into the sap has not, as yet, proved successful. Certain manufacturers have placed blight remedies on the market; however, not only have all those tested proved of no value in checking the blight, but in most cases they have been injurious to the trees themselves. It is suggested that the general use of commercial blight remedies, on nursery stock at least, be avoided except when tried first in an experimental way in order to test the value of the remedy.

Control of agents of dissemination

The elimination of certain disseminating agents is an important consideration. It has been demonstrated that controlling the aphids is frequently an essential step in preventing the spread of blight bacteria. The greatest necessity at the present time, however, is a means of eradicating from the nursery the numerous other sucking insects which occur on stock that is susceptible to fire blight. Of these blight disseminators the tarnished plant bug (*Lygus pratensis*) appears to be the most important.*

Sanitary measures essential

The most satisfactory means of controlling the blight is by strict sanitation and an attempt to eradicate the disease from any given locality. All sources of infection should be destroyed. Old orchard trees—such

*Cooperative experiments with the Department of Entomology at Cornell University are now under way for the control of the sucking bugs occurring on nursery stock.

as pear, apple, or quince—in the vicinity of the nursery usually favor the blight, in that frequently such trees become diseased and, for years to follow, are sources of infection for nursery stock. Unless they are given special attention and kept free from the disease, their presence is a menace to the nursery. Old, neglected orchard trees should be removed, and every effort made to keep the surroundings clean. Old hawthorn and wild crab-apple trees along the fence rows or in near-by pastures frequently harbor the blight. Such trees should be destroyed. Too much emphasis cannot be laid on the necessity of a thorough and systematic cleaning-up of all diseased trees before growth starts in the spring. Orchard trees in the vicinity should be inspected at least once a week throughout the summer; all blighted twigs, shoots, and water sprouts should be cut out, the cut disinfected with corrosive sublimate 1-1,000, and the prunings burned.

A thorough cleaning-up and removal of all sources of disease in early spring naturally reduces the possibility of blight infection in the nursery. As previously pointed out, however, bees and other insects frequently carry the bacteria from oozing hold-over cankers, which are especially common on orchard trees, to blossoms that often appear on the two-years-old quince stock. Since the production of fruit by such trees not only causes a stunted growth for the tree but also furnishes a source of infection at blossoming time, it is considered good practice to pinch off or remove all quince blossoms before they open.

Inspection and eradication

With the presence of disseminating agents that greatly favor the spread of twig blight, thorough and frequent inspections of all susceptible stock become necessary in order to keep the disease under control. It is often necessary to inspect certain blocks each day and to cut out the diseased twigs as fast as they appear. In every case the cut surface should be disinfected with corrosive sublimate 1-1,000. For the work of inspection the equipment illustrated in Fig. 71 has proved convenient. An ordinary pruning knife is used to remove the diseased twigs, which are carried out of the block in a sack and burned. The supply of corrosive sublimate can be carried in a bottle, and the sponge used for swabbing the wound can be moistened from time to time.

By thorough and systematic inspections the number of new infections can be greatly reduced, and often, by prompt and careful work in removing the first infections, an epidemic can be completely averted. In cutting out the new infections the pruner should remove the entire twig and make a clean cut at the trunk. This gives greater likelihood that all the blighted tissue has been removed. Moreover, severe pruning of the young twigs of nursery trees leads to a bushy growth rather than to the ordinary development of long, unbranched shoots. When the infections have progressed rapidly down the twig, extending into the trunk of the tree, the removal of the entire tree is advisable.

If the first-year budded stock becomes diseased the blighted trees should be immediately grubbed out. Usually the bacteria are extremely active in such tender growth, and the larger part of the tree is soon involved by the disease. Cutting back below the diseased area causes a crook in the trunk of the tree, and such stock can seldom be put on the market.

At budding time there is usually little danger in cutting diseased scions unless the blight is particularly abundant in the two- and three-years-old trees. However, since infection occurs three to ten days before the tissues show any external signs of the disease, it is possible, under such conditions, to transmit the blight bacteria to the seedling block in the scions that appear perfectly healthy. On the other hand, the number of seedlings that become infected in this manner is seldom large. The greatest spread of the disease occurs at rebudding time, when the budbers attempt to rebud the few blighted seedlings that may be present and in this way carry the bacteria on their knives to healthy stocks. The inner bark of the diseased stocks appears discolored and water-soaked, and frequently the gummy exudation is somewhat abundant on the trunk, which is browned or blackened in color. The infected seedlings should be grubbed out and burned. When it is found that an incision has been made in the bark of a blighted tree, the knife should be sterilized in a 5-per-cent solution of carbolic acid before it is used for budding other seedlings. The carbolic acid can be carried in a small bottle (Fig. 71). Corrosive sublimate is likely to injure most metallic tools and should therefore not be used for sterilizing the knives.

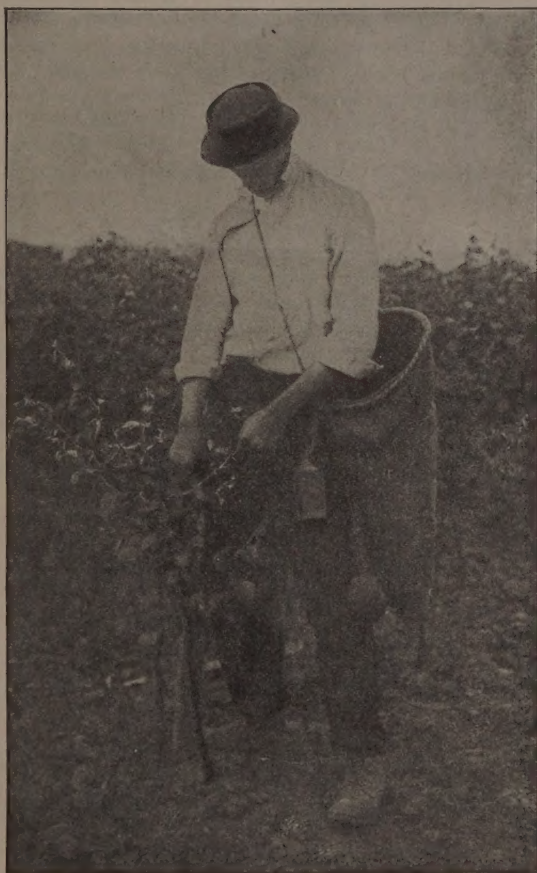


FIG. 71.—Cutting blight from nursery stock. Note the bag in which the blighted shoots are placed, the bottle of corrosive sublimate, and the sponge at the end of the string

Cultivation versus blight

It is evident that cultivation and manuring influence the amount of blight. High cultivation favors more succulent growth, and the trees

naturally remain susceptible to attacks of blight bacteria for a longer period of time than in the absence of cultivation. Furthermore, insects that injure the trees by puncture or biting—as aphids, tarnished plant bugs, and the like—are usually more likely to attack the succulent growth. Since these insects are known to spread the blight, it is to be expected that the results of their work will be more evident on stock which has received high cultivation and manuring than on that which has not.

On the other hand, since cultivation and a good soil medium are necessary for the maximum growth of nursery stock, it does not appear practicable to decrease the amount of cultivation and manuring in any degree whatever. It is believed that blight can be controlled successfully regardless of the amount of cultivation that the trees receive.

Summary

The following measures have proved effective in the work of blight control conducted in large nurseries for the past four years:

- (1) Hold-over blight and sources of infection should be eradicated in the early spring before growth starts.
- (2) Blossom buds that appear, especially on quince stock, should be removed.
- (3) Frequent and systematic inspections of the diseased area should be made two or three times a week and all infections should be cut out and burned.
- (4) Spreading of the disease in the seedling block should be avoided.

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